Silver Shiner (*Notropis photogenis*) in Ontario: Distribution and Habitat Use

William R. Glass[1], Robin Gaspardy[1], Jason Barnucz[1], Lynn D. Bouvier[1], and Nicholas E. Mandrak[2]

[1]Central and Arctic Region
Fisheries and Oceans Canada
867 Lakeshore Road
Burlington, ON
L7S 1A1

[2]Department of Biological Sciences
University of Toronto Scarborough
1265 Military Trail
Toronto, ON
M1C 1A4

2016

Canadian Manuscript Report of Fisheries and Aquatic Sciences 3105

Fisheries and Oceans Canada | Pêches et Océans Canada

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of Fisheries and Oceans Canada, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in the data base *Aquatic Sciences and Fisheries Abstracts*.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques de Pêches et Océans Canada, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications à part entière. Le titre exact figure au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la base de données Résumés des sciences aquatiques et halieutiques.

Les rapports manuscrits sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre.

Les numéros 1 à 900 de cette série ont été publiés à titre de Manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme Manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de Rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de Rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Canadian Manuscript Report of
Fisheries and Aquatic Sciences 3105

2016

Silver Shiner (*Notropis photogenis*) in Ontario: Distribution and Habitat Use

by

William R. Glass[1], Robin Gaspardy[1], Jason Barnucz[1], Lynn D. Bouvier[1], and Nicholas E. Mandrak[2]

[1]Central and Arctic Region
Fisheries and Oceans Canada
867 Lakeshore Road
Burlington, ON
L7S 1A1

[2]Department of Biological Sciences
University of Toronto Scarborough
1265 Military Trail
Toronto, ON
M1C 1A4

© Her Majesty the Queen in Right of Canada, 2015.

PDF version: Cat. No. Fs97-4/3105E-PDF ISBN 978-0-660-05997-6 ISSN 1488-5387

Correct citation for this publication:

Glass, W.R., Gaspardy, R., Barnucz, J., Bouvier, L.D., and Mandrak, N.E. Silver Shiner (*Notropis photogenis*) in Ontario: Distribution and Habitat Use. Can. Manuscr. Rep. Fish. Aquat. Sci. 3105 iv + 27 p.

TABLE OF CONTENTS

ABSTRACT iv

RÉSUMÉ iv

INTRODUCTION 5

METHODS 5

Field sampling 5

Habitat preference assessment 6

RESULTS 6

Field sampling 6

Habitat preference assessment 7

DISCUSSION 8

ACKNOWLEDGEMENTS 9

REFERENCES 9

ABSTRACT

Silver Shiner (*Notropis photogenis*), a species at risk in Canada, is listed as Special Concern under Schedule 3 of the *Species at Risk Act* and is assessed as Threatened by COSEWIC. The species is relatively understudied in Canada but is known to occur in four watersheds in southern Ontario: Sixteen Mile Creek; Bronte Creek; Grand River; and, Thames River. Sampling was conducted using a bag seine in each of the four watersheds to gain a better understanding of the types of habitats utilized by Silver Shiner. An electivity index was used to compare the habitat where Silver Shiner was captured to the overall habitat in order to determine the habitat preference for the species in Canada. Silver Shiner preferred moderate to deeper water depths (> 0.6 m) with moderate current (0.25 – 0.49 m/s), while the shallowest depths (<0.4 m) and swiftest current areas (> 0.5 m/s) were avoided. Sand or gravel substrate was preferred by Silver Shiner, while organic substrate was avoided. This study was the first targeted sampling for Silver Shiner across all watersheds where the species is known to exist in Canada and the results will be useful for delineating Silver Shiner critical habitat as well as planning of future sampling efforts in prospective watersheds that may hold Silver Shiner populations.

RÉSUMÉ

Le méné miroir (*Notropis photogenis*), une espèce en péril au Canada, est considéré comme étant une espèce préoccupante aux termes de l'annexe 3 de la *Loi sur les espèces en péril* et est désigné comme espèce menacée par le COSEPAC. Il s'agit d'une espèce relativement peu étudiée au Canada, mais présente dans quatre bassins hydrographiques du sud de l'Ontario : le ruisseau Sixteen Mile; le ruisseau Bronte; la rivière Grand et la rivière Thames. L'échantillonnage a été effectué à l'aide d'une senne dans chacun des quatre bassins hydrographiques afin de mieux comprendre les types d'habitats utilisés par le méné miroir. Un indice d'électivité a servi à comparer l'habitat où des ménés miroirs ont été capturés à l'ensemble de l'habitat afin de déterminer les préférences en matière d'habitat de l'espèce au Canada. Le méné miroir préfère des profondeurs d'eau modérées à plus profondes (> 0,6 m), avec un courant modéré (de 0,25 à 0,49 m/s), tandis qu'il évite les profondeurs minimales (< 0,4 m) et les zones de courant les plus rapides (> 0,5 m/s). Le méné miroir préfère le substrat de sable ou de gravier, et évite les substrats organiques. Cette étude a été le premier échantillonnage ciblé pour le méné miroir dans tous les bassins versants où l'espèce a été observée au Canada, et les résultats seront utiles pour délimiter l'habitat essentiel du méné miroir ainsi que pour planifier les futurs échantillonnages dans les bassins hydrographiques potentiels qui peuvent contenir des populations de méné miroir.

INTRODUCTION

Silver Shiner (*Notropis photogenis*) is a small, elongated, silvery fish in the Cyprinidae (minnow) family. The species closely resembles two other *Notropis* species, Emerald Shiner (*Notropis atherinoides*) and Rosyface Shiner (*Notropis rubellus*), but can be distinguished from these species by the presence of a pair of dark crescents of melanophores on the dorsal side of the head between the nostrils (Trautman 1981). Silver Shiner also has a comparatively larger eye and its dorsal fin is not set as far back as that of Emerald Shiner and Rosyface Shiner (Trautman 1981).

Silver Shiner is designated as Special Concern under Schedule 3 of the *Species at Risk Act* in Canada and has been assessed as Threatened by COSEWIC due to its limited distribution and potential for loss or degradation of its habitat (COSEWIC 2011). The first recorded Silver Shiner in Canada was found in the Grand River in 1971 (Gruchy et al. 1973). Subsequent sampling efforts and reexamination of museum specimens have determined that the species is found in four watersheds in southwestern Ontario: Grand River, Thames River, Bronte Creek, and Sixteen Mile Creek (COSEWIC 2011). There are additional historical records from the Saugeen River; however, to date no verified population has been found (COSEWIC 2011). This species is at the northern edge of its range in Canada and is found throughout the Ohio, Tennessee, and Wabash river systems in the United States (Mckee and Parker 1982) where it is not considered to be at risk.

Silver Shiner inhabits medium to large streams in areas of strong current and alternating riffle – pool morphology (McKee and Parker 1982). In previous surveys in southwestern Ontario, Silver Shiner distribution appeared to be limited by stream gradient, where the species was found in areas of moderate gradient (0.5 – 1.9 m/km) and primary bottom composition of pebble and cobble (McKee and parker 1982). To date, no systematic sampling has been conducted throughout the entirety of the Canadian range of Silver Shiner to determine habitat preference. The objectives of this study are to determine Silver Shiner distribution and habitat preference throughout its Canadian range.

METHODS

FIELD SAMPLING

Field sampling was conducted in each of the four watersheds in which Silver Shiner are known historically to occur in Canada. Watersheds were divided into sampling units or segments bounded by access points within which multiple sites were sampled over a single day. A random sub-set of these segments were selected for sampling in the two larger systems (Grand and Thames rivers), while all segments were sampled within the smaller systems (Bronte and Sixteen Mile Creek watersheds), where accessibility allowed. Segments within each watershed were sampled in random order while avoiding sampling adjacent sections on consecutive days.

Sampling locations were selected based on vicinity to historical sampling locations (targeted), were chosen randomly based on habitat availability, or were selected to fill in gaps between historical sampling locations. A standard minimum distance of ten times the stream width between sampling locations within a segment was employed during location selection. Each selected sampling location was treated as a sampling reach, where three to five sites were sampled within a distance of ten times the stream width. Site selection within the reach targeted

visibly different habitat types (i.e., riffle/run/pool) to allow for a representation of the diverse river habitats. Sites within a reach were sampled in a downstream to upstream direction to minimize disturbance of sites prior to sampling.

All field sampling was conducted between May 31 and July 14, 2011. Fishes were collected using a bag seine (9.14 m length, 3 mm mesh) in approximately 10 m hauls. Collections were conducted at 232 sites across the sampled watersheds (Table 1, Figure 1). A total of 83 sites were sampled on the Thames River and its tributaries between May 31 and June 3, and between July 11 and 14, 2011 (Figure 2); 95 sites were sampled on the Grand River and its tributaries on June 2 and between June 20 and 24, 2011 (Figure 3); 30 sites were sampled on Bronte Creek between June 13 and 16, 2011 (Figure 4); and, 24 sites were sampled on Sixteen Mile Creek between June 13 and 16, 2011 (Figure 4). Crews conducted three consecutive hauls at each site with a ten minute waiting period between each haul to allow disturbed but uncaptured fishes to resume their position within the site, following Baldwin (1983) methods. Captured fishes were identified to species and enumerated in the field, recording total number and minimum and maximum total lengths for each species in each haul. Fishes were released downstream of the site once all sampling at that site was complete. A voucher specimen or voucher photograph of each species was kept at each site for laboratory verification at a later date. The total length (mm) of all Silver Shiner was measured and a maximum of 50 Silver Shiner from each site were kept for species verification and future laboratory analyses.

Habitat data were collected subsequent to fish sampling. Water chemistry data were collected at the reach level, from the centre of the reach, as representative data for all sites within the reach. Water temperature (°C), conductivity (µS), pH, and dissolved oxygen (mg/L) were measured using a handheld YSI unit. At each sampling site, dominant substrate type was identified and water depth (m) and water velocity (m/s) were measured.

HABITAT PREFERENCE ASSESSMENT

An electivity index (Jacobs 1974) was calculated for each of the habitat variables. This index is a measure of the habitat where Silver Shiner was detected as a proportion of the overall observed habitat. The electivity index (D) is calculated as

$$D = [r-p] / [(r+p) - 2rp]$$

Where r is the proportion of individuals that are found at a particular habitat interval and p is the proportion of the total habitat in that interval (Luttrell et al. 2002). Values for electivity range from -1.0 to +1.0 and were interpreted according to Moyle and Baltz (1985) where values -1.0 to -0.5 indicate strong avoidance, -0.49 to -0.25 indicate mild avoidance, -0.24 to + 0.24 indicate no preference, +0.25 to +0.49 indicate mild preference, and +0.5 to + 1.0 indicate strong preference.

RESULTS

FIELD SAMPLING

A total of 25970 fishes were captured representing 55 species across the four watersheds (Table 1). Silver Shiner was detected at 74 sites (32% of sites; see Appendix 1 for specific Silver Shiner detection locations) and a total of 804 Silver Shiner were captured throughout the four watersheds (Table 1).

A total of 83 sites were sampled (Figure 2) and 7967 fishes were captured representing 42 species in the Thames River, Middle Thames River, North Thames River, and Medway Creek (Table 1 and 2). Sampling at 40 sites in the main branch of the Thames River resulted in the capture of 1030 fishes representing 22 species. Fifteen sites were sampled in the Middle Thames River resulting in the capture of 487 fishes representing 17 species. Sampling at 18 sites in the North Thames River resulted in the capture of 3331 fishes of 35 species. Medway Creek, a tributary flowing into the North Thames River, was also sampled at 10 sites resulting in the capture of 3119 fishes representing 32 species. A total of 185 Silver Shiner were captured at 22 sites (26.5% of sites) in the Thames watershed. Silver Shiner was detected at six sites in the Thames River, four sites in the Middle Thames River, four sites in the North Thames River and eight sites in Medway Creek.

A total of 95 sites were sampled in the Grand River watershed (Figure 3), resulting in the capture of 13038 fishes representing 42 species (Table 1 and 2). There were 40 sites sampled in the Grand River resulting in the capture of 5781 fishes representing 38 species. In the Conestogo River, 21 sites were sampled resulting in the capture of 3406 fishes from 21 species. Five sites were sampled in Laurel Creek capturing 11 fishes of eight species and 25 sites were sampled in the Nith River resulting in the capture of 2832 fishes of 25 species. A total of 10 sites were sampled in the Speed River resulting in the capture of 891 fishes representing 16 species. A total of 121 Silver Shiner were captured at 25 sites (26.3% of sites) in the Grand River watershed. Silver Shiner was detected at 13 sites in the Grand River, eight sites in the Nith River, and four sites in the Conestogo River. Silver Shiner was not detected in the Speed River or Laurel Creek.

In Bronte Creek, 30 sites were sampled (Figure 4), resulting in the capture of 3881 fishes representing 33 species (Table 1 and 2). A total of 57 Silver Shiner were captured from 14 sites (46.7% of sites).

In Sixteen Mile Creek, 24 sites were sampled (Figure 4), resulting in the capture of 1717 fishes representing 22 species (Table 1 and 2). A total of 441 Silver Shiner were captured and the species was detected at 13 sites (54.2% of sites).

HABITAT PREFERENCE ASSESSMENT

The analyses of electivity indices demonstrated that Silver Shiner showed preference for several habitat intervals while showing avoidance for others (Table 3) and there was relative agreement for habitat preference among watersheds. In general, moderate to deeper depths with moderate water velocity were preferred. Sand or gravel was the preferred substrate depending on watershed and there was no clear temperature preference among watersheds.

Within the Thames River watershed, strong preference was shown for sand substrate, water velocity between 0.25 – 0.49 m/s, and water temperature between 19.0 – 21.9 °C. Mild preference was shown for water depths between 0.6 and 0.99 m. Strong avoidance was shown for boulder, gravel, silt, and clay substrate types. Strong avoidance was also shown for sites with the fastest water velocity (0.5 – 0.74 m/s, >0.75 m/s), the coldest water (13.0 – 15.9 °C) and water temperatures between 22.0 – 24.9 °C.

Within the Grand River watershed, strong avoidance was shown for sand and organic substrates and sites with the highest water temperatures (22.0 – 24.9 °C). Mild preference was shown for sites with boulder substrate and the deepest depths sampled (0.8 – 0.99 m, > 1.0 m). Mild avoidance was shown for depths between 0.2 – 0.39 m and no preference was shown for any particular water velocity.

Within Bronte Creek, Silver Shiner exhibited strong preference for gravel substrate while showing strong avoidance of cobble and mild avoidance of bedrock and boulder substrates. Strong avoidance was shown for shallow depths (0.2 – 0.39 m) and mild preference for moderate depths (0.6 – 0.79, 0.8 – 0.99 m). Strong preference was exhibited for water velocity between 0.25 – 0.49 m/s and Silver Shiner strongly avoided the swiftest current areas (0.5 – 0.74, >0.75 m/s).

Within Sixteen Mile Creek no preference was shown for either of the substrate types (boulder; cobble) observed at the sampling sites. Silver Shiner exhibited mild preference for the deepest depths (0.8 – 0.99 m, >1 m) and strongly avoided the shallowest depths (0 – 0.19 m, 0.2 – 0.39 m, 0.4 – 0.59 m). Mild preference was shown for slow and moderate current (0.01 – 0.24, 0.25 – 0.49 m/s) while strongly avoiding the swiftest current areas (0.5 – 0.74, >0.75 m/s).

DISCUSSION

Silver Shiner was successfully detected at multiple sites in each of the watersheds that were sampled. In the larger watersheds (Grand and Thames rivers), Silver Shiner was also detected in each of the sub-watersheds that were sampled except for the Speed River and Laurel Creek in the Grand River watershed. The sampling conducted during this survey has confirmed the presence of Silver Shiner populations throughout the historical distribution of the species in Bronte Creek and the Thames River watersheds (COSEWIC 2011). It has also detected the species in much greater numbers than has been previously reported and extended the known occupied reaches in Sixteen Mile Creek (COSEWIC 2011). Within the Grand River watershed, historical populations in the Speed River and Laurel Creek could not be confirmed.

All of the areas where Silver Shiner was collected during this survey were found in medium to large streams with moderate gradient as previously reported to be preferable for the species by McKee and Parker (1982). However, Silver Shiner was not detected in Laurel Creek or Speed River. Laurel Creek, unlike the other streams that were sampled, is a small, second order stream that is entirely within an urban area and, thus, is highly impacted by human activities and the continued presence of a population of Silver Shiner is unlikely. Gammon and Gammon (1993) similarly reported that Silver Shiner was a species that was negatively impacted due to water quality decline in the Eel River, Indiana.

Unlike Laurel Creek, the Speed River is a fourth-order stream with seemingly suitable habitat for Silver Shiner. The small number of sites sampled on the Speed River may be the reason the species was not detected. Only 10 sites were sampled and of those, several were in habitat that Silver Shiner was found to avoid based on sampling in the other waterbodies during this study (organic substrate, shallow depth, high velocity), leaving only five of the sites that were sampled that had suitable habitat. Greater sampling effort in suitable habitat would be needed to determine if the historical population of Silver Shiner in the Speed River is still present.

The habitat preference (and avoidance) that Silver Shiner exhibited in this study is similar to what has been previously reported for the species. We found that Silver Shiner showed similar preference for substrate (sand / gravel) as previously reported (McKee and Parker 1982; Trautman 1981); however, we found that deeper depths were preferred, likely due to the fact that previous studies did not target depths greater than 1 m. A strong avoidance was also shown for the highest water velocities (> 0.5 m/s), which corresponds to the observation by McKee and Parker (1982) that Silver Shiner distribution is limited by stream gradient and the

species was not found in high gradient reaches of the Grand River. The avoidance of the shallowest areas (<0.4 m) along with the avoidance of high water velocity indicates that the species is not utilizing shallow riffle areas. This observation coincides with the habitat description by Gruchy et al. (1973) that Silver Shiner was found in deep riffles of flowing pools.

No pattern for water temperature preference was evident between watersheds, this is likely due to the wide range of observed temperatures due to the timing of our sampling, which occurred from May through July and water temperature fluctuations would be expected over the course of the summer season.

This study was the first to focus specifically on refining Silver Shiner preferred habitat throughout its known range in Canada. Although this project incorporated substantial sampling effort, Silver Shiner remains an understudied species in Canada and future research is required. A large section of the North Thames River was not sampled during this study due to high water conditions that made the sites inaccessible. Future sampling of this section of the river, along with Fanshawe Lake, an impoundment of the North Thames River, should be conducted to determine the current extent of Silver Shiner. Targeted sampling of the Saugeen River to determine if a population of Silver Shiner is present should also be conducted.

This study and the previous work targeted adult specimens during the late spring and early summer periods. The spawning habitat remains unknown for the species; though it was postulated by McKee and Parker (1982) that spawning takes place in waters deeper than 1 m. The habitat of the juvenile stage of this species is another area that bears investigating. Young and Koops (2012) identified the survival of the juvenile life stage as an important factor in the extinction risk for the Canadian populations, thus, identification of the spawning and juvenile rearing habitat for this species should be a future research priority. The findings of this study will be useful for informing the designation of critical habitat for the Silver Shiner in Canada. Additionally, the habitat preferences we have identified will be important for focusing future surveys of medium and large streams that may hold populations of Silver Shiner.

ACKNOWLEDGEMENTS

We thank Danielle Hosick, Ryan Kelly, David Marson, Jason Read, and Lisa Vollbrecht of Fisheries and Oceans Canada for assistance with sampling activities. Assistance was also provided by Conservation Halton staff. Funding was provided by the Fisheries and Oceans Canada Species at Risk Program.

REFERENCES

Baldwin, M.E. 1983. Habitat use, distribution, life history, and interspecific associations of *Notropis photogenis* (Silver Shiner: Osteichthyes: Cyprinidae) in Canada, with comparisons to *Notropis rubellus* (Rosyface Shiner). M.Sc. Thesis. Carleton University, Ottawa, ON.

COSEWIC. 2011. COSEWIC assessment and status report on the Silver Shiner *Notropis photogenis* in Canada. Committee on the Status of Endangered Wildlife in Canada. xi + 45 p.

Gammon, J.R. and Gammon, C.W. 1993. Changes in the fish community of the Eel River resulting from agriculture. Proc. Indiana Acad. Sci. 102: 67-82.

Gruchy, C.G., Bowen, R.H., and Gruchy, I.M. 1973. First records of the Silver Shiner, *Notropis photogenis*, from Canada. J. Fish. Res. Board Can. 30: 1379-1382.

Jacobs, J. 1974. Quantitative measurement of food selection. Oecologia. 14: 413-417.

Luttrell, G.R., Echelle, A.A., and Fisher, W.L. 2002. Habitat correlates of the distribution of *Macrhybopsis hyostoma* (Teleostei: Cyprinidae) in western reaches of the Arkansas River. Trans. Kansas Acad. Sci. 105: 153-161.

McKee, P.M. and Parker, B.J. 1982. The distribution, biology, and status of the fishes *Campostoma anomalum*, *Clinostomus elongates*, *Notropis photogenis* (Cyprinidae), and *Fundulus notatus* (Cyprinodontidae) in Canada. Can. J. Zool. 60: 1347-1358.

Moyle, P.B. and Baltz, D.M. 1985. Microhabitat use by an assemblage of California stream fishes: developing criteria for instream flow determinations. Trans. Amer. Fish. Soc. 114: 695-704.

Trautman, M.B. 1981. The Fishes of Ohio. Ohio State University Press, Columbus. xxvi + 782 p.

Young, J.A.M. and Koops, M.A. 2012. Recovery potential modelling of Silver Shiner (*Notropis photgenis*) in Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/131. iv + 29 p.

Table 1. Number of sites sampled, number of Silver Shiner detected, and number of fish species detected in each watershed.

Watershed	No. Sites	No. Sites with Silver Shiner	No. Silver Shiner	Total Fishes Captured	No. Species Detected
16 Mile Creek	**24**	**13**	**441**	**1902**	**22**
Bronte Creek	**30**	**14**	**57**	**3881**	**33**
Grand River	**95**	**25**	**121**	**13033**	**42**
Grand River	40	13	73	5781	38
Conestogo River	15	4	11	3406	21
Laurel Creek	5	0	0	11	8
Nith River	25	8	37	2832	25
Speed River	10	0	0	891	16
Thames River	**83**	**22**	**185**	**7967**	**42**
Middle Thames River	15	8	37	487	17
North Thames River	18	4	15	3331	35
Thames River	40	4	109	1030	22
Medway Creek	10	6	24	3119	32
TOTAL	**232**	**74**	**804**	**26788**	**55**

Table 2. Fish species captured in each watershed during field sampling. Species are listed in phylogenetic order.

	Grand River Watershed							Thames River Watershed			
Species	16 Mile	Bronte	Grand River	Nith River	Speed River	Laurel Creek	Conestogo River	Thames River	North Thames	Middle Thames	Medway Creek
Lepisosteus osseus								X			X
Chrosomus eos		X							X		
Cyprinella spiloptera			X	X	X		X	X	X		X
Cyprinus carpio			X					X		X	
Luxilus chrysocephalus	X	X	X	X	X	X	X	X	X	X	X
Luxilus cornutus	X	X	X	X	X	X	X	X	X	X	X
Nocomis biguttatus	X		X	X	X		X	X	X		
Nocomis micropogon	X	X	X	X	X		X	X		X	
Notemigonus crysoleucas		X							X		X
Notropis atherinoides		X		X				X	X	X	
Notropis heterolepis		X									
Notropis hudsonius		X									
Notropis photogenis	X	X	X	X			X	X	X	X	X
Notropis rubellus	X	X	X	X	X		X	X	X	X	X
Notropis volucellus		X	X	X				X	X	X	X
Pimephales notatus	X	X	X	X	X		X	X	X	X	X
Pimephales promelas		X	X	X			X		X	X	
Rhinichthys atratulus		X	X		X			X			
Rhinichthys cataractae	X	X	X	X		X	X				X
Semotilus atromaculatus	X	X	X	X	X	X	X	X		X	
Campostoma anomalum			X				X		X	X	X
Carpiodes cyprinus								X			
Catostomus commersoni	X	X	X	X	X	X	X	X	X	X	
Hypentelium nigricans	X	X	X					X	X	X	X
Moxostoma anisurum				X				X	X		
Moxostoma duquesnei			X						X		
Moxostoma erythrurum			X	X				X	X		
Moxostoma macrolepidotum			X	X							
Ameiurus nebulosus			X						X		
Noturus flavus	X	X					X	X		X	
Oncorhynchus kisutch	X	X									

Oncorhynchus mykiss		X									
Oncorhynchus tshawytscha	X	X									
Esox lucius			X						X		
Percopsis omiscomaycus		X									
Labidesthes sicculus		X									
Fundulus diaphanous		X									
Culaea inconstans			X				X		X	X	
Ambloplites rupestris		X	X	X	X	X	X	X	X	X	X
Lepomis sp. hybrid			X								
Lepomis gibbosus	X	X	X		X			X	X	X	
Lepomis macrochirus	X		X					X	X		X
Micropterus dolomieu	X	X	X	X	X			X	X	X	X
Micropterus salmoides	X	X	X					X	X		
Pomoxis nigromaculatus	X										
Ammocrypta pellucida								X			
Etheostoma blennoides			X	X	X		X	X	X	X	X
Etheostoma caeruleum	X	X	X	X	X	X	X	X	X	X	
Etheostoma flabellare	X	X	X					X			
Etheostoma microperca			X				X		X		
Etheostoma nigrum	X	X	X	X			X	X	X	X	
Perca flavescens			X					X	X		
Percina caprodes			X								
Percina maculata			X	X			X	X			
Neogobius melanostomus		X									

Table 3. Electivity indices showing habitat preference for Silver Shiner in each of the watersheds.

		Grand River Watershed				Thames River Watershed			
Variable	Variable Range	# Sites	#Silver Shiner	D	Electivity	# Sites	#Silver Shiner	D	Electivity
Substrate	Bedrock	0	-	-	-	0	-	-	-
	Boulder	8	16	0.25	Mild Preference	2	0	-1.00	Strong Avoidance
	Cobble	64	85	0.07	No Preference	33	53	-0.30	Mild Avoidance
	Gravel	16	20	-0.01	No Preference	11	3	-0.81	Strong Avoidance
	Sand	6	0	-1.00	Strong Avoidance	12	77	0.69	Strong Preference
	Organic	1	0	-1.00	Strong Avoidance	0	-	-	-
	Silt	0	-	-	-	1	0	-1.00	Strong Avoidance
	Clay	0	-	-	-	1	0	-1.00	Strong Avoidance
Depth (m)	0-0.19m	2	3	0.07	No Preference	0	-	-	-
	0.20-0.39	24	20	-0.28	Mild Avoidance	15	1	0.01	No Preference
	0.40-0.59	33	36	-0.13	No Preference	32	23	0.12	No Preference
	0.60-0.79	22	24	-0.12	No Preference	19	81	0.44	Mild Preference
	0.80-0.99	6	17	0.40	Mild Preference	12	52	0.28	Mild Preference
	>1	7	23	0.48	Mild Preference	5	28	0.15	No Preference
Water Velocity (m/s)	None	8	11	0.04	No Preference	12	13	-0.38	Mild Avoidance
	0.01-0.24	22	30	0.04	No Preference	18	31	-0.16	No Preference
	0.25-0.49	26	39	0.11	No Preference	30	129	0.61	Strong Preference
	0.50-0.74	23	23	-0.16	No Preference	15	11	-0.55	Strong Avoidance
	>0.75	15	18	-0.04	No Preference	8	1	-0.90	Strong Avoidance
Water Temperature (°C)	13-15.9	0	-	-	-	5	0	-1.00	Strong Avoidance
	16-18.9	15	17	-0.07	No Preference	8	15	-0.09	No Preference
	19-21.9	75	104	0.24	No Preference	30	146	0.74	Strong Preference
	22-24.9	5	0	-1.00	Strong Avoidance	30	6	-0.89	Strong Avoidance
	25-27.9	0	-	-	-	10	18	-0.12	No Preference

		Sixteen Mile Creek				Bronte Creek			
Variable	Variable Range	# Sites	# Silver Shiner	D	Electivity	# Sites	# Silver Shiner	D	Electivity
Substrate	Bedrock	0	-	-	-	6	5	-0.44	Mild Avoidance
	Boulder	4	94	0.16	No Preference	3	3	-0.33	Mild Avoidance
	Cobble	20	342	-0.16	No Preference	14	12	-0.53	Strong Avoidance
	Gravel	0	-	-	-	5	31	0.71	Strong Preference
	Sand	0	-	-	-	2	6	0.24	No Preference
	Organic	0	-	-	-	0	-	-	-
	Silt	0	-	-	-	0	-	-	-
	Clay	0	-	-	-	0	-	-	-
Depth (m)	0-0.19m	2	0	-1.00	Strong Avoidance	0	-	-	-
	0.20-0.39m	4	3	-0.93	Strong Avoidance	5	0	-1.00	Strong Avoidance
	0.40-0.59m	3	0	-1.00	Strong Avoidance	11	16	-0.19	No Preference
	0.60-0.79m	8	192	0.22	No Preference	8	29	0.48	Mild Preference
	0.80-0.99m	3	128	0.49	Mild Preference	3	9	0.26	Mild Preference
	>1m	4	113	0.27	Mild Preference	3	3	-0.33	Mild Avoidance
Water Velocity (m/s)	None	2	36	0.00	No Preference	1	2	0.03	No Preference
	0.01-0.24 m/s	4	133	0.39	Mild Preference	5	11	0.09	No Preference
	0.25-0.49 m/s	6	175	0.36	Mild Preference	11	40	0.61	Strong Preference
	0.50-0.74 m/s	4	27	-0.50	Strong Avoidance	11	4	-0.77	Strong Avoidance
	>0.75 m/s	6	25	-0.70	Strong Avoidance	2	0	-1.00	Strong Avoidance
Water Temperature (C)	13-15.9C	3	21	-0.48	Mild Avoidance	6	0	-1.00	Strong Avoidance
	16-18.9C	9	206	0.20	No Preference	21	56	0.92	Strong Preference
	19-21.9C	8	85	-0.35	Mild Avoidance	3	1	-0.72	Strong Avoidance
	22-24.9C	3	30	-0.32	Mild Avoidance	0	-	-	-
	25-27.9C	1	94	0.73	Strong Preference	0	-	-	-

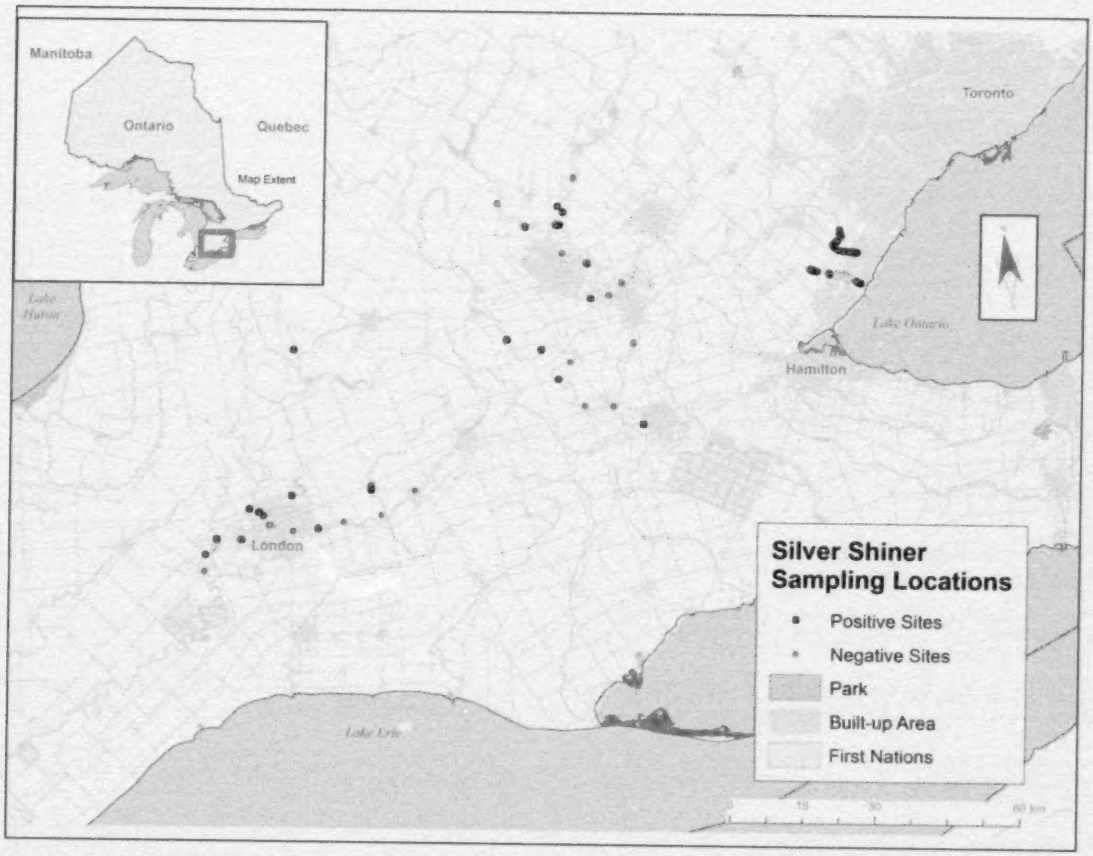

Figure 1. Map of sampling locations in all four watersheds where Silver Shiner are known to occur in Ontario. Green circles indicate sites where Silver Shiner was detected.

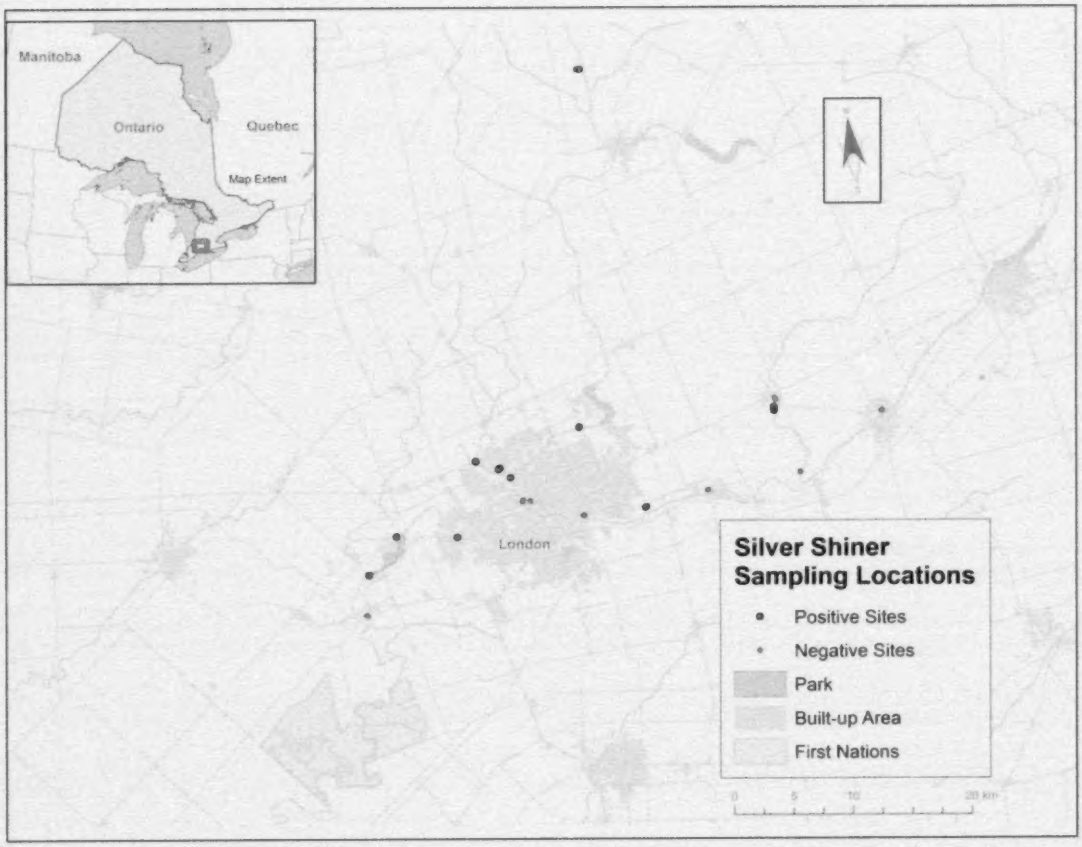

Figure 2. Map of sampling locations in the Thames River watershed. Green circles indicate sites where Silver Shiner was detected.

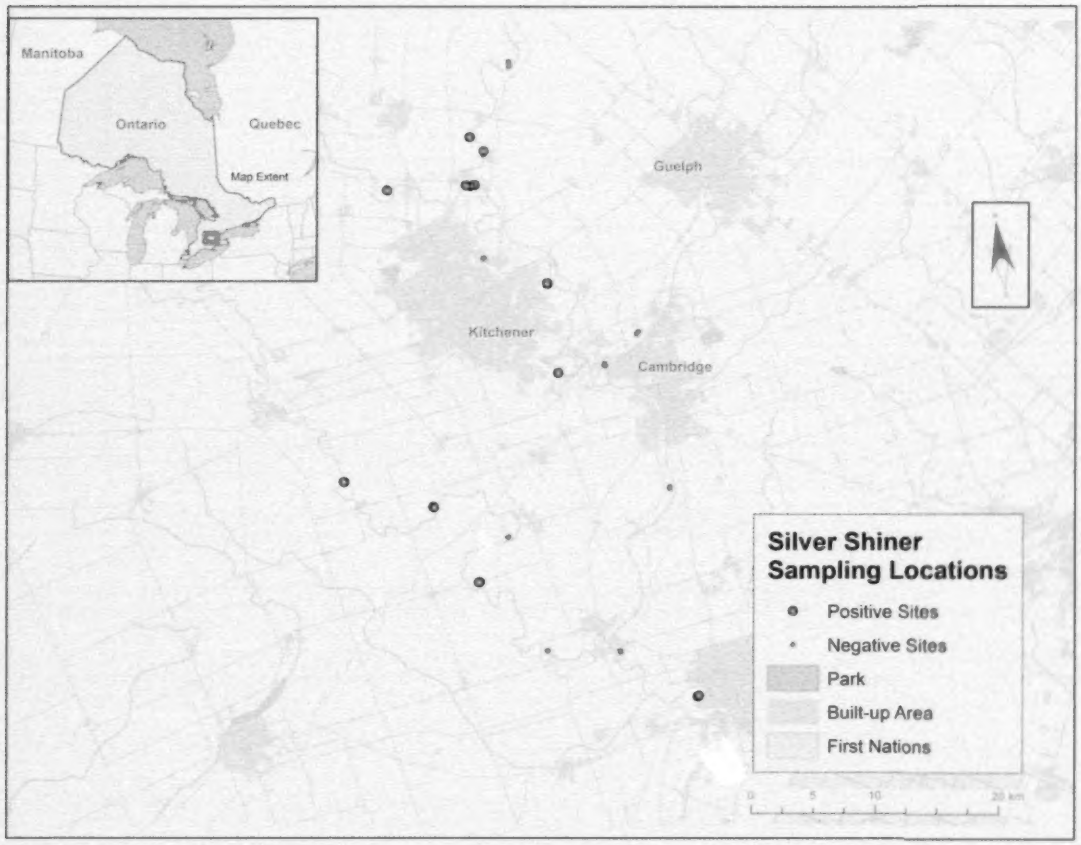

Figure 3. Map of sampling locations in the Grand River watershed. Green circles indicate sites where Silver Shiner was detected.

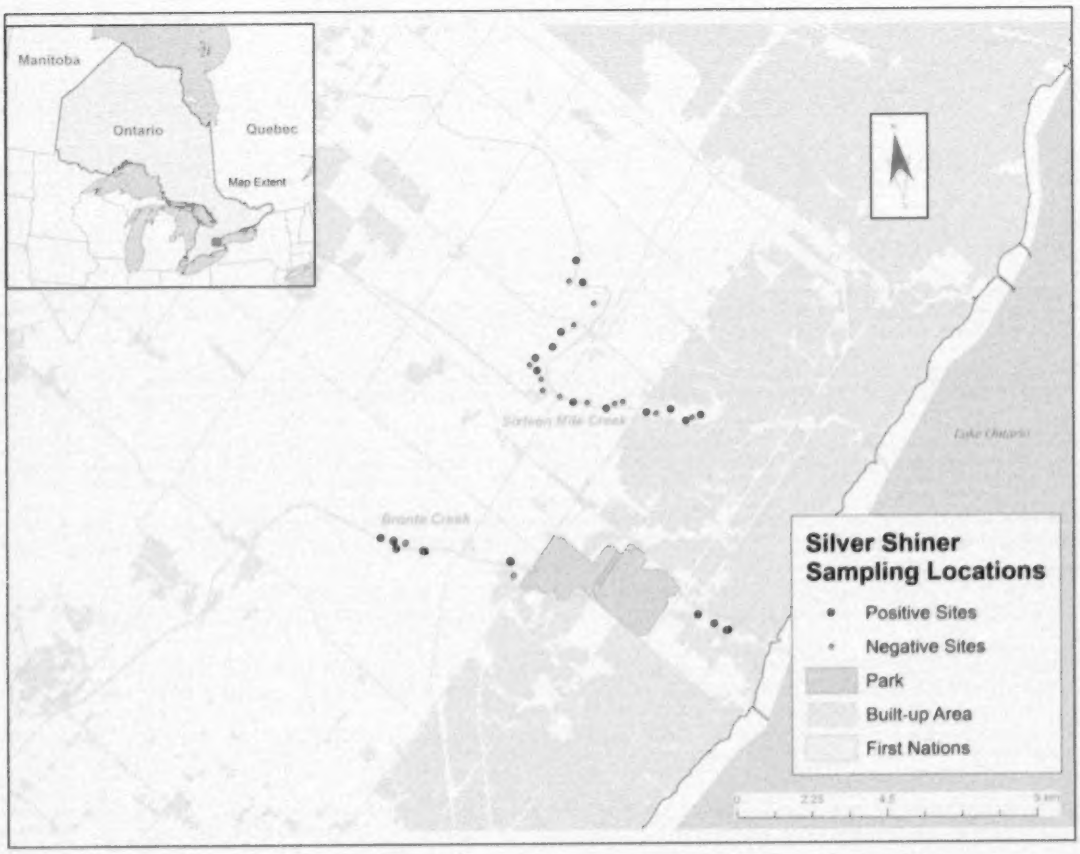

Figure 4. Map of sampling locations in the Bronte Creek and Sixteen Mile Creek watersheds. Green circles indicate sites where Silver Shiner was detected.

*Appendix 1. a) Sampling locations in Sixteen Mile Creek. *indicates site where Silver Shiner was detected.*

Site #	Date	Narrative Locality Description	Latitude	Longitude
1*	13-Jun-11	~600M u/s Upper Middle, 211m u/s walking bridge, Site 1 Sub 1	43.45609	-79.72903
2	13-Jun-11	~1.06km d/s Upper Middle, Site 1 Sub 2	43.45563	-79.73224
3*	13-Jun-11	~1.3 km d/s Upper Middle Site 1 Sub 3	43.45485	-79.73469
4*	13-Jun-11	~950 d/s Dundas Site 2 Sub 1	43.45826	-79.73993
5	13-Jun-11	~425m d/s of Dundas Rd. Site 2 Sub 2	43.45751	-79.74546
6*	13-Jun-11	~200m d/s of Dundas Rd. Site 2 Sub 3	43.45793	-79.74899
7	14-Jun-11	~500 m U/S Dundas St. W - Site 1, Subsite 1	43.46126	-79.75742
8	14-Jun-11	~825 m U/S of Dundas St. W - Site 2, Subsite 2	43.46091	-79.76044
9*	14-Jun-11	~1.1 km D/S of Dundas St W - Site 1, Subsite 3	43.45977	-79.76369
10	14-Jun-11	~1.7 km D/S of HWY 407 - Site 2, Subsite 1	43.46175	-79.77062
11*	14-Jun-11	~1.24 km D/S of HWY 407 - Site 2, Subsite 2	43.46212	-79.77578
12	14-Jun-11	~540m D/S of HWY 407 - Site 2, Subsite 3	43.46390	-79.78055
13	15-Jun-11	90m U/S of hwy 407	43.46591	-79.78667
14	15-Jun-11	~640m U/S of hwy 407	43.46903	-79.78696
15*	15-Jun-11	~1.4km U/S of hwy 407	43.47147	-79.78829
16	15-Jun-11	~1.7 km U/S 407 - Site 2, subsite 1	43.47312	-79.79076
17*	15-Jun-11	~ 2 km D/S of 407 - Site 2, Subsite 2	43.47496	-79.78858
18*	15-Jun-11	~2.7 km D/S of 407 - Site 2, subsite 3	43.47767	-79.78187
19*	16-Jun-11	North of 407, ~500m D/S of 4th line walking bridge	43.48164	-79.77831
20	16-Jun-11	North of 407, 20m U/S of 4th line walking bridge	43.48327	-79.77345
21	16-Jun-11	North of 407, ~900m U/S of 4th line walking bridge	43.48883	-79.76538
22*	16-Jun-11	~2.1 km U/S of 4th Line walking bridge - Site 2, Subsite 1	43.49476	-79.76896
23	16-Jun-11	~2.7 km U/S of 4th line walking bridge - Site 2, Subsite 2	43.49541	-79.77395
24*	16-Jun-11	~3.8 km U/S of 4th line walking bridge - Site 2, Subsite 3	43.50099	-79.77080

*Appendix 1. b) Sampling locations in Bronte Creek. *indicates site where Silver Shiner was detected.*

Site #	Date	Narrative Locality Description	Latitude	Longitude
25*	13-Jun-11	Petro Canada Park @ Fork - Site 1, Subsite 3 of 3	43.39674	-79.72464
26*	13-Jun-11	Petro Canada Park @ Fork - Site 1, Subsite 2 of 3	43.39674	-79.72542
27	13-Jun-11	Petro Canada Park @ Fork - Site 1, Subsite 1 of 3	43.39677	-79.72540
28*	13-Jun-11	Petro Canada Park ~500m U/S - Site 2, Subsite 3	43.39879	-79.72971
29*	13-Jun-11	Petro Canada Park ~500m U/S - Site 2, Subsite 2	43.39881	-79.72981
30	13-Jun-11	Petro Canada Park ~500m U/S - Site 2, Subsite 1	43.39876	-79.73000
31*	13-Jun-11	~900m D/S from QEW, ~120m D/S of CN bridge	43.40151	-79.73542
32	13-Jun-11	~900m D/S from QEW, ~120m D/S of CN bridge	43.40164	-79.73562
33	13-Jun-11	~900m D/S from QEW, ~120m D/S of CN bridge	43.40183	-79.73591
34	14-Jun-11	~400m U/S of Dundas St - Site 1, subsite 2	43.41565	-79.80255
35	14-Jun-11	~400m U/S of Dundas St - Site 1, subsite 3	43.41569	-79.80244
36	14-Jun-11	~400m U/S of Dundas st - Site 1, Subsite 1	43.41598	-79.80247
37*	14-Jun-11	~1.1km U/S of Dundas St - Site 2, Subsite 3	43.41970	-79.80309
38	14-Jun-11	~1.1km U/S of Dundas St - Site 2, subsite 2	43.41982	-79.80320
39*	14-Jun-11	~1.1 km U/S of Dundas st - Site 2, subsite 1	43.41995	-79.80340
40*	15-Jun-11	~300m U/S of Appleby Ln, 185m D/S of 1983 site	43.42429	-79.83459
41*	15-Jun-11	~300m U/S of Appleby Ln, 185m D/S of 1983 site	43.42431	-79.83483
42*	15-Jun-11	~300m U/S of Appleby Ln, 185m D/S of 1983 historical	43.42450	-79.83517
43	15-Jun-11	~500m D/S of 2nd line - Site 1, subsite 3	43.42702	-79.84137
44	15-Jun-11	~500m D/S of 2nd line - Site 1, Subsite 2	43.42693	-79.84147
45	15-Jun-11	~500m D/S of 2nd line - Site 1, Subsite 1	43.42682	-79.84145
46	16-Jun-11	~150m D/S of 2nd Line - site 3, subsite 3	43.42547	-79.84475
47*	16-Jun-11	~150m D/S of 2nd Line - site 3, subsite 2	43.42554	-79.84505
48	16-Jun-11	~150m D/S of 2nd Line - site 3, subsite 1	43.42571	-79.84526
49*	16-Jun-11	~90m U/S of 2nd line - Site 2, Subsite 3	43.42762	-79.84582
50*	16-Jun-11	~90m U/S of 2nd line - Site 2, Subsite 2	43.42783	-79.84585
51	16-Jun-11	~90m U/S of 2nd line - Site 2, Subsite 1	43.42784	-79.84617
52	16-Jun-11	~700m D/S of Sidrabene, U/S of 2nd line - Site 1, Subsite 3	43.42882	-79.85044
53*	16-Jun-11	~700m D/S of Sidrabene, U/S of 2nd line - Site 1, Subsite 2	43.42882	-79.85049
54	16-Jun-11	~700m D/S of Sidrabene, U/S of 2nd line - Site 1, Subsite 1	43.42878	-79.85074

*Appendix 1. c) Sampling locations in the Grand River watershed. *indicates site where Silver Shiner was detected.*

Site #	Date	Waterbody	Narrative Locality Description	Latitude	Longitude
55	24-Jun-11	Grand River	Brant CA, downstream of Wilke's Dam - Site 1 Subsite 1	43.14914	-80.29606
56*	24-Jun-11	Grand River	Brant CA, downstream of Wilke's Dam - Site 1 Subsite 2	43.14925	-80.29604
57*	24-Jun-11	Grand River	Brant CA, downstream of Wilke's Dam - Site 1 Subsite 3	43.14929	-80.29580
58*	24-Jun-11	Grand River	Brant CA, downstream of Wilke's Dam - Site 1 Subsite 4	43.14967	-80.29519
59*	24-Jun-11	Grand River	Brant CA, downstream of Wilke's Dam - Site 1 Subsite 5	43.14971	-80.29491
60	24-Jun-11	Grand River	~400m upstream of Bean Park, Paris, Ontario - Site 1 Subsite 5	43.18527	-80.36951
61	24-Jun-11	Grand River	~400m upstream of Bean Park, Paris, Ontario - Site 1 Subsite 4	43.18571	-80.36953
62	24-Jun-11	Grand River	~400m upstream of Bean Park, Paris, Ontario - Site 1 Subsite 3	43.18596	-80.36958
63	24-Jun-11	Grand River	~400m upstream of Bean Park, Paris, Ontario - Site 1 Subsite 2	43.18621	-80.36977
64	24-Jun-11	Grand River	~400m upstream of Bean Park, Paris, Ontario - Site 1 Subsite 1	43.18649	-80.36995
65	21-Jun-11	Grand River	Alongside Hwy 24 - Site 2 Subsite 5	43.30429	-80.31110
66	21-Jun-11	Grand River	Alongside Hwy 24 - Site 2 Subsite 4	43.30448	-80.31094
67	21-Jun-11	Grand River	Alongside Hwy 24 - Site 2 Subsite 3	43.30498	-80.31126
68	21-Jun-11	Grand River	Alongside Hwy 24 - Site 2 Subsite 2	43.30499	-80.31104
69	21-Jun-11	Grand River	Alongside Hwy 24 - Site 2 Subsite 1	43.30565	-80.31095
70	22-Jun-11	Grand River	~80m North of Old Mill Rd (Doon Dam Path) - Site 3 Subsite 5	43.39413	-80.41392
71	22-Jun-11	Grand River	~80m North of Old Mill Rd (Doon Dam Path) - Site 3 Subsite 4	43.39419	-80.41425
72	22-Jun-11	Grand River	~80m North of Old Mill Rd (Doon Dam Path) - Site 3 Subsite 3	43.39429	-80.41443
73	22-Jun-11	Grand River	~80m North of Old Mill Rd (Doon Dam Path) - Site 3 Subsite 2	43.39442	-80.41480
74*	22-Jun-11	Grand River	~80m North of Old Mill Rd (Doon Dam Path) - Site 3 Subsite 1	43.39466	-80.41492
75*	23-Jun-11	Grand River	~40m NE of access on Otterbein Rd - Site 2 Subsite 5	43.46117	-80.42043
76*	23-Jun-11	Grand River	~40m NE of access on Otterbein Rd - Site 2 Subsite 4	43.46138	-80.42043
77*	23-Jun-11	Grand River	~40m NE of access on Otterbein Rd - Site 2 Subsite 2	43.46128	-80.42085
78*	23-Jun-11	Grand River	~40m NE of access on Otterbein Rd - Site 2 Subsite 3	43.46168	-80.42065
79*	23-Jun-11	Grand River	~40m NE of access on Otterbein Rd - Site 2 Subsite 1	43.46176	-80.42106
80	23-Jun-11	Grand River	Upstream of Peel St. West of Winterbourne - Site 2 Subsite 1	43.56013	-80.47701
81	23-Jun-11	Grand River	Upstream of Peel St. West of Winterbourne - Site 2 Subsite 2	43.56145	-80.47681
82	23-Jun-11	Grand River	Upstream of Peel St. West of Winterbourne - Site 2 Subsite 3	43.56218	-80.47681
83*	23-Jun-11	Grand River	Upstream of Peel St. West of Winterbourne - Site 2 Subsite 4	43.56284	-80.47637
84	23-Jun-11	Grand River	Upstream of Peel St. West of Winterbourne - Site 2 Subsite 5	43.56325	-80.47586
85*	23-Jun-11	Grand River	~500m U/S of Buggy Ln/Crooks tract	43.57378	-80.48952
86*	23-Jun-11	Grand River	~500m U/S of Buggy Ln/Crooks tract	43.57384	-80.48966
87	23-Jun-11	Grand River	~500m U/S of Buggy Ln/Crooks tract	43.57390	-80.48990
88	23-Jun-11	Grand River	~500m U/S of Buggy Ln/Crooks tract	43.57384	-80.49033
89	23-Jun-11	Grand River	~500m U/S of Buggy Ln/Crooks tract	43.57394	-80.49070

90	21-Jun-11	Grand River	Upstream of 8th Line, West of Highway 21 - Site 2 Subsite 1	43.62510	-80.44652
91	21-Jun-11	Grand River	Upstream of 8th Line, West of Highway 21 - Site 2 Subsite 2	43.62564	-80.44618
92	21-Jun-11	Grand River	Upstream of 8th Line, West of Highway 21 - Site 2 Subsite 3	43.62657	-80.44645
93	21-Jun-11	Grand River	Upstream of 8th Line, West of Highway 21 - Site 2 Subsite 4	43.62697	-80.44597
94	21-Jun-11	Grand River	Upstream of 8th Line, West of Highway 21 - Site 2 Subsite 5	43.62858	-80.44644
95	22-Jun-11	Nith River	~115m upstream of Trussler Rd (CR-36) - Site 1 Subsite 5	43.18922	-80.44154
96	22-Jun-11	Nith River	~115m upstream of Trussler Rd (CR-36) - Site 1 Subsite 4	43.18929	-80.44171
97	22-Jun-11	Nith River	~115m upstream of Trussler Rd (CR-36) - Site 1 Subsite 3	43.18938	-80.44146
98	22-Jun-11	Nith River	~115m upstream of Trussler Rd (CR-36) - Site 1 Subsite 2	43.18946	-80.44205
99	22-Jun-11	Nith River	~115m upstream of Trussler Rd (CR-36) - Site 1 Subsite 1	43.18941	-80.44237
100*	21-Jun-11	Nith River	~230m D/S of Blenhiem Rd - Site 1, Subsite 5	43.24297	-80.50515
101*	21-Jun-11	Nith River	~230m D/S of Blenhiem Rd - Site 1, Subsite 4	43.24306	-80.50530
102	21-Jun-11	Nith River	~230m D/S of Blenhiem Rd - Site 1, Subsite 3	43.24282	-80.50550
103*	21-Jun-11	Nith River	~230m D/S of Blenhiem Rd - Site 1, Subsite 2	43.24284	-80.50604
104	21-Jun-11	Nith River	~230m D/S of Blenheim Rd bridge - Site 1, Subsite 1	43.24256	-80.50632
105	22-Jun-11	Nith River	~50m upstream of Trussler Rd (SE Piper St) Site 2 Subsite 5	43.27498	-80.47445
106	22-Jun-11	Nith River	~50m upstream of Trussler Rd (SE Piper St) Site 2 Subsite 4	43.27505	-80.47433
107	22-Jun-11	Nith River	~50m upstream of Trussler Rd (SE Piper St) Site 2 Subsite 3	43.27512	-80.47434
108	22-Jun-11	Nith River	~50m upstream of Trussler Rd (SE Piper St) Site 2 Subsite 2	43.27501	-80.47417
109	22-Jun-11	Nith River	~50m upstream of Trussler Rd (SE Piper St) - Site 2 Subsite 1	43.27524	-80.47391
110*	02-Jun-11	Nith River	U/S of township rd 12 - Site 1, Subsite 5	43.30075	-80.54675
111*	02-Jun-11	Nith River	U/S of township rd 12 - Site 1, Subsite 4	43.30037	-80.54633
112	02-Jun-11	Nith River	U/S of township rd 12 - Site 1, Subsite 3	43.30030	-80.54630
113*	02-Jun-11	Nith River	U/S of township rd 12 - Site 1, Subsite 2	43.30017	-80.54610
114	02-Jun-11	Nith River	U/S of township rd 12 - Site 1, Subsite 1	43.29998	-80.54591
115*	02-Jun-11	Nith River	U/S River Rd, West of Plattsville - Site 2, Subsite 5	43.32254	-80.63341
116*	02-Jun-11	Nith River	U/S River Rd, West of Plattsville - Site 2, Subsite 4	43.32283	-80.63405
117	02-Jun-11	Nith River	U/S River Rd, West of Plattsville - Site 2, Subsite 3	43.32265	-80.63380
118	02-Jun-11	Nith River	U/S River Rd, West of Plattsville - Site 2, Subsite 2	43.32283	-80.63405
119	02-Jun-11	Nith River	U/S River Rd, West of Plattsville - Site 2, Subsite 1	43.32315	-80.63408
120	20-Jun-11	Speed River	D/S of King st East bridge near Fountain st North intersection	43.39809	-80.36869
121	20-Jun-11	Speed River	D/S of King st East bridge near Fountain st North intersection	43.39820	-80.36847
122	20-Jun-11	Speed River	D/S of King st East bridge near Fountain st North intersection	43.39817	-80.36791
123	20-Jun-11	Speed River	D/S of King st East bridge near Fountain st North intersection	43.39815	-80.36756
124	20-Jun-11	Speed River	D/S of King st East bridge near Fountain st North intersection	43.39942	-80.36835
125	20-Jun-11	Speed River	D/S of Beaverdale Rd bridge - Site 2, Subsite 1	43.42030	-80.33495
126	20-Jun-11	Speed River	D/S of Beaverdale Rd bridge - Site 2, Subsite 2	43.42084	-80.33432
127	20-Jun-11	Speed River	D/S of Beaverdale Rd bridge - Site 2, Subsite 3	43.42134	-80.33363

128	20-Jun-11	Speed River	D/S of Beaverdale Rd bridge - Site 2, Subsite 4	43.42167	-80.33329
129	20-Jun-11	Speed River	D/S of Beaverdale Rd bridge - Site 2, Subsite 5	43.42197	-80.33286
130	21-Jun-11	Laurel Creek	Upstream of Carisbrook Dr. and mouth at Grand River	43.48326	-80.48193
131	21-Jun-11	Laurel Creek	Upstream of Carisbrook Dr. and mouth at Grand River	43.48338	-80.48223
132	21-Jun-11	Laurel Creek	Upstream of Carisbrook Dr. and mouth at Grand River	43.48330	-80.48244
133	21-Jun-11	Laurel Creek	Upstream of Carisbrook Dr. and mouth at Grand River	43.48303	-80.48301
134	21-Jun-11	Laurel Creek	Upstream of Carisbrook Dr. and mouth at Grand River	43.48262	-80.48324
135	23-Jun-11	Conestogo R.	U/S of mouth @ Grand River - D/S of Sawmill Rd	43.53831	-80.48669
136*	23-Jun-11	Conestogo R.	U/S of confluence @ Grand River - D/S of Sawmill Rd	43.53796	-80.48724
137*	23-Jun-11	Conestogo R.	U/S of confluence @ Grand River - D/S of Sawmill Rd	43.53730	-80.49147
138	23-Jun-11	Conestogo R.	U/S of confluence @ Grand River - D/S of Sawmill Rd	43.53780	-80.49448
139*	23-Jun-11	Conestogo R.	U/S of confluence @ Grand River - D/S of Sawmill Rd	43.53791	-80.49595
140*	22-Jun-11	Conestogo R.	Downstream of Three Bridge Rd	43.53761	-80.57500
141	22-Jun-11	Conestogo R.	Downstream of Three Bridge Rd	43.53746	-80.57471
142	22-Jun-11	Conestogo R.	Downstream of Three Bridge Rd	43.53721	-80.57443
143	22-Jun-11	Conestogo R.	Downstream of Three Bridge Rd	43.53644	-80.57330
144	22-Jun-11	Conestogo R.	Downstream of Three Bridge Rd	43.53596	-80.57310
145	22-Jun-11	Conestogo R.	U/S of Herrgott Rd - Historical: CMNFI-1981-0436.1	43.58330	-80.64273
146	22-Jun-11	Conestogo R.	U/S of Herrgott Rd - Historical: CMNFI-1981-0436.1	43.58375	-80.64319
147	22-Jun-11	Conestogo R.	U/S of Herrgott Rd - Historical: CMNFI-1981-0436.1	43.58411	-80.64346
148	22-Jun-11	Conestogo R.	U/S of Herrgott Rd - Historical: CMNFI-1981-0436.1	43.58420	-80.64391
149	22-Jun-11	Conestogo R.	U/S of Herrgott Rd - Historical: CMNFI-1981-0436.1	43.58438	-80.64412

*Appendix 1d) Sampling locations in the Thames River Watershed. *indicates site where Silver Shiner was detected.*

Site#	Date	Waterbody	Narrative Locality Description	Latitude	Longitude
150	12-Jul-11	Thames River	~200m d/s Hwy 2 / Site 2 Subsite1	42.90392	-81.42346
151	12-Jul-11	Thames River	~200m d/s Hwy 2 / Site 2 Subsite2	42.90407	-81.42365
152	12-Jul-11	Thames River	~200m d/s Hwy 2 / Site 2 Subsite 3	42.90416	-81.42378
153	12-Jul-11	Thames River	~200m d/s Hwy 2 / Site 2 Subsite 4	42.90421	-81.42409
154	12-Jul-11	Thames River	~200m d/s Hwy 2 / Site 2 Subsite 5	42.90445	-81.42454
155	14-Jul-11	Thames River	~140m u/s Komoka Rd. Historical: CMNF1-1986-0266.1	42.93489	-81.41996
156	14-Jul-11	Thames River	~140m d/s Komoka Rd. Historical: CMNFI-1986-0266.1	42.93503	-81.41994
157	14-Jul-11	Thames River	~140m d/s Komoka Rd. Historical: CMNFI-1986-0266.1	42.93512	-81.42004
158*	14-Jul-11	Thames River	~140m d/s Komoka Rd. Historical: CMNFI-1986-0266.1	42.93526	-81.42010
159*	14-Jul-11	Thames River	~140m d/s Komoka Rd. Historical: CMNFI-1986-0266.1	42.93521	-81.41981
160	13-Jul-11	Thames River	u/s Oxford St. / Historical: CMNFI-1986-0264.1	42.96381	-81.39043
161	13-Jul-11	Thames River	u/s Oxford St. / Historical: CMNFI-1986-0264.1	42.96394	-81.39020
162	13-Jul-11	Thames River	u/s Oxford St. / Historical: CMNFI-1986-0264.1	42.96404	-81.39021
163*	13-Jul-11	Thames River	u/s Oxford St. / Historical: CMNFI-1986-0264.1	42.96411	-81.39009
164	13-Jul-11	Thames River	u/s Oxford St. / Historical: CMNFI-1986-0264.1	42.96466	-81.38976
165	12-Jul-11	Thames River	d/s dam @ Storybook Park, Springbank	42.96122	-81.32797
166*	12-Jul-11	Thames River	d/s dam @ Storybook Park, Springbank	42.96127	-81.32722
167*	12-Jul-11	Thames River	d/s dam @ Storybook Park, Springbank	42.96120	-81.32701
168	12-Jul-11	Thames River	d/s dam @ Storybook Park, Springbank	42.96134	-81.32674
169	12-Jul-11	Thames River	d/s dam @ Storybook Park, Springbank	42.96119	-81.32653
170	14-Jul-11	Thames River	St. Julien Park, London, Ontario; Site 2 Subsite 1	42.97339	-81.19653
171	14-Jul-11	Thames River	St. Julien Park, London, Ontario; Site 2 Subsite 2	42.97336	-81.19629
172	14-Jul-11	Thames River	St. Julien Park, London, Ontario; Site 2 Subsite 3	42.97333	-81.19581
173	14-Jul-11	Thames River	St. Julien Park, London, Ontario; Site 2 Subsite 4	42.97335	-81.19530
174	14-Jul-11	Thames River	St. Julien Park, London, Ontario; Site 2 Subsite 5	42.97338	-81.19518
175*	11-Jul-11	Thames River	u/s Veteran's Memroial / Historical: CMNFI-1986-0378.1	42.97717	-81.13195
176	11-Jul-11	Thames River	u/s Veteran's Memroial / Historical: CMNFI-1986-0378.1	42.97746	-81.13129
177	11-Jul-11	Thames River	u/s Veteran's Memroial / Historical: CMNFI-1986-0378.1	42.97764	-81.13127
178	11-Jul-11	Thames River	u/s Veteran's Memroial / Historical: CMNFI-1986-0378.1	42.97790	-81.13072
179	11-Jul-11	Thames River	u/s Veteran's Memroial / Historical: CMNFI-1986-0378.1	42.97785	-81.13055
180	12-Jul-11	Thames River	N. of Mill Rd / Hamilton Rd. / Historical: CMNFI-1986-0245.1	42.98786	-81.06699
181	12-Jul-11	Thames River	N. of Mill Rd / Hamilton Rd. / Historical: CMNFI-1986-0245.1	42.98787	-81.06677
182	12-Jul-11	Thames River	N. of Mill Rd / Hamilton Rd. / Historical: CMNFI-1986-0245.1	42.98793	-81.06686
183	12-Jul-11	Thames River	N. of Mill Rd / Hamilton Rd. / Historical: CMNFI-1986-0245.1	42.98802	-81.06669
184	12-Jul-11	Thames River	N. of Mill Rd / Hamilton Rd. / Historical: CMNFI-1986-0245.1	42.98796	-81.06638

185	13-Jul-11	Thames River	~50m d/s Mutual St. S. / Historical: CMNFI-1986-0247.1	43.04206	-80.88367
186	13-Jul-11	Thames River	~50m d/s Mutual St. S. / Historical: CMNFI-1986-0247.1	43.04206	-80.88348
187	13-Jul-11	Thames River	~50m d/s Mutual St. S. / Historical: CMNFI-1986-0247.1	43.04226	-80.88333
188	13-Jul-11	Thames River	~50m d/s Mutual St. S. / Historical: CMNFI-1986-0247.1	43.04229	-80.88307
189	13-Jul-11	Thames River	u/s Mutual St. S. / Historical: CMNFI-1986-0247.1	43.04246	-80.88287
190	11-Jul-11	North Thames	Harris Park / Historical: CMNFI-1981-0478.1 / Site 1 Subsite 1	42.98635	-81.25842
191	11-Jul-11	North Thames	Harris Park / Historical: CMNFI-1981-0478.1 / Site 1 Subsite 2	42.98647	-81.25832
192	11-Jul-11	North Thames	Harris Park / Historical: CMNFI-1981-0478.1 / Site 1 Subsite 3	42.98670	-81.25032
193	11-Jul-11	North Thames	Harris Park / Historical: CMNFI-1981-0478.1 / Site 1 Subsite 4	42.98669	-81.25808
194	11-Jul-11	North Thames	Harris Park / Historical: CMNFI-1981-0478.1 / Site 1 Subsite 5	42.98759	-81.25767
195	01-Jun-11	North Thames	~300m d/s UWO bridge (University Drive); Site 2 Subsite 1	43.00600	-81.26920
196*	01-Jun-11	North Thames	~300m d/s UWO bridge (University Drive); Site 2 Subsite 2	43.00549	-81.26942
197	01-Jun-11	North Thames	~300m d/s UWO bridge (University Drive); Site 2 Subsite 3	43.00509	-81.26958
198	01-Jun-11	North Thames	~300m d/s UWO bridge (University Drive); Site 2 Subsite 4	43.00489	-81.26969
199	01-Jun-11	North Thames	~300m d/s UWO bridge (University Drive); Site 2 Subsite 5	43.00471	-81.26985
200	02-Jun-11	North Thames	d/s Clark Rd, below Fanshaw Park; Site 2 Subsite 5	43.04170	-81.19637
201*	02-Jun-11	North Thames	d/s Clark Rd, below Fanshaw Park; Site 2 Subsite 4	43.04176	-81.19598
202	02-Jun-11	North Thames	d/s Clark Rd, below Fanshaw Park; Site 2 Subsite 3	43.04182	-81.19601
203*	02-Jun-11	North Thames	d/s Clark Rd, below Fanshaw Park; Site 2 Subsite 2	43.04193	-81.19584
204	02-Jun-11	North Thames	d/s Clark Rd, below Fanshawe Park; Site 2 Subsite 1	43.04201	-81.19562
205	31-May-11	North Thames	d/s 12th line; E of RR137; 75km N of St. Mary's Site 1 Subsite1	43.32013	-81.17986
206*	31-May-11	North Thames	d/s 12th line; E of RR137; 75km N of St. Mary's Site 1 Subsite 2	43.32003	-81.17673
207	31-May-11	North Thames	d/s 12th line; E of RR137; 75km N of St. Mary's Site 1 Subsite 3	43.32016	-81.17659
208	01-Jun-11	Middle Thames	58 Sd. Rd. Right of Way; NW of Putnam; Site 1 Subsite 5	42.99790	-80.97103
209	01-Jun-11	Middle Thames	58 Sd. Rd. Right of Way; NW of Putnam; Site 1 Subsite 4	42.99811	-80.97095
210	01-Jun-11	Middle Thames	58 Sd. Rd. Right of Way; NW of Putnam; Site 1 Subsite 3	42.99814	-80.97091
211	01-Jun-11	Middle Thames	58 Sd. Rd. Right of Way; NW of Putnam; Site 1 Subsite 2	42.99829	-80.97085
212	01-Jun-11	Middle Thames	58 Sd. Rd. Right of Way; NW of Putnam; Site 1 Subsite 1	42.99840	-80.97090
213*	31-May-11	Middle Thames	S of Thamesford, 66Rd.; Site 2 Subsite 5	43.04661	-80.99428
214*	31-May-11	Middle Thames	S of Thamesford, 66Rd.; Site 2 Subsite 1	43.04682	-80.99429
215	31-May-11	Middle Thames	S of Thamesford, 66Rd.; Site 2 Subsite 3	43.04689	-80.99445
216*	31-May-11	Middle Thames	S of Thamesford, 66Rd.; Site 2 Subsite 2	43.04702	-80.99435
217*	31-May-11	Middle Thames	S of Thamesford, 66Rd.; Site 2 Subsite 4	43.04961	-80.99426
218	03-Jun-11	Middle Thames	Thamesford Lion's River Park; Site 1 Subsite 2	43.05506	-80.99201
219	03-Jun-11	Middle Thames	Thamesford Lion's River Park; Site 1 Subsite 2	43.05535	-80.99236
220	03-Jun-11	Middle Thames	Thamesford Lion's River Park; Site 1 Subsite 2	43.05583	-80.99275
221	03-Jun-11	Middle Thames	Thamesford Lion's River Park; Site 1 Subsite 2	43.05632	-80.99300
222	03-Jun-11	Middle Thames	Thamesford Lion's River Park; Site 1 Subsite 1	43.05657	-80.99310

223*	02-Jun-11	Medway Creek	u/s Windemere/Western Rd./ Historical: CMNFI-1986-0268.1	43.01328	-81.28024
224*	02-Jun-11	Medway Creek	u/s Windemere/Western Rd./ Historical: CMNFI-1986-0268.1	43.01316	-81.28047
225	02-Jun-11	Medway Creek	u/s Windemere/Western Rd./ Historical: CMNFI-1986-0268.1	43.01300	-81.28048
226	02-Jun-11	Medway Creek	u/s Windemere/Western Rd./ Historical: CMNFI-1986-0268.1	43.01265	-81.28111
227*	02-Jun-11	Medway Creek	u/s Windemere/Western Rd./ Historical: CMNFI-1986-0268.1	43.01220	-81.28143
228*	01-Jun-11	Medway Creek	d/s Fanshawe Pkwy @ Medway Creek; Site 1 Subsite 1	43.01886	-81.30431
229*	01-Jun-11	Medway Creek	d/s Fanshawe Pkwy @ Medway Creek confluence	43.01897	-81.30432
230*	01-Jun-11	Medway Creek	d/s Fanshawe Pkwy @ Medway Creek confluence	43.01908	-81.30443
231*	01-Jun-11	Medway Creek	d/s Fanshawe Pkwy @ Medway Creek confluence	43.01930	-81.30469
232*	01-Jun-11	Medway Creek	d/s Fanshawe Pkwy @ Medway Creek confluence	43.01946	-81.30469